Simmons, Alisha M. (MSFC-NAS802002)[MAINTHIA]

From: Chandler, Michael O. (MSFC-VP62)
Sent: Tuesday, October 16, 2007 12:31 PM
To: Simmons, Alisha M. (MSFC-NAS802002)[MAINTHIA]
Cc: Summers, Freda G. (MSFC-VP60)
Subject: Re: 1676 request

Abstract:

Observations of a Newly "Captured" Magnetosheath Field Line: Evidence for Double Reconnection.

Michael O. Chandler, Levon, A. Avanov, Paul D. Craven, Forrest S. Mozer, and Thomas E. Moore

We have begun an investigation of the nature of the low-latitude boundary layer in the mid-altitude cusp region using data from the Polar spacecraft. This region has been routinely sampled for about three months each year for the periods 1999-2001 and 2004-2006. The low-to-mid-energy ion instruments frequently observed dense, magnetosheath-like plasma deep (in terms of distance from the magnetopause and in invariant latitude) in the magnetosphere. One such case, taken during a period of northward interplanetary magnetic field (IMF), shows magnetosheath ions within the magnetosphere with velocity distributions resulting from two separate merging sites along the same field lines. Cold ionospheric ions were also observed counterstreaming along the field lines, evidence that these field lines were closed. These results are consistent with the hypothesis that double merging can produce closed field lines populated by solar wind plasma. Through the use of individual cases such as this and statistical studies of a braoder database we seek to understand the morphology of the LLBL as it projects from the sub-solar region into the cusp. We will present preliminary results of our ongoing study.

On Oct 16, 2007, at 12:23 PM, Simmons, Alisha M. (MSFC-NAS802002)[MAINTHIA] wrote:

> Michael,
>
> I have received your request for clearance on presentation entitled "Observations of a Newly "Captured" Magnetosheath Field Line: Evience for a "Double Reconnection." It is optional that you provide a brief abstract to accompany your presentation describing the contents of your presentation. If you do not, the Center for Aerospace Information will write an abstract for you. We give you that option to write your own abstract instead of CASI writing one for you. If you wish to provide an abstract, please send ASAP. If I don't hear back from you or receive the abstracts, I will go ahead and finish the process for your 1676 for approval, and allow CASI to write one for you. If you have any questions, please feel free to give me a call. Thanks!
>
> **Alisha Simmons**
> **Mainthia Technologies**
> **Bldg 4200/Rm 522A**
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> **alisha.m.simmons@nasa.gov**

MSFC-526-PRESENTATION

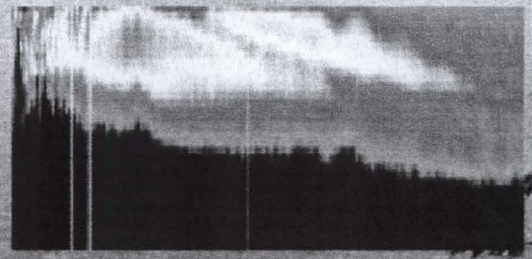
Observations of a Newly "Captured" Magnetosheath Field Line: Evidence for "Double Reconnection"

M. Chandler

L. Avanov

P. Craven

(and everyone else associated with TIDE)



Hypothesis: High-latitude magnetic merging can occur on the same field line in both hemispheres.

Consequences: Field lines connected previously to the solar wind become "captured" by the terrestrial magnetic field and become closed "terrestrial" field lines containing magnetosheath plasma. Presents a possible mechanism for the formation of the LLBL and, the cold, dense plasma sheet during northward IMF conditions.

Observations: Lavraud et al., 2005 used Cluster observations of bidirectional, heated electrons to infer the presence of magnnetosheath plasma on dayside, closed field lines.

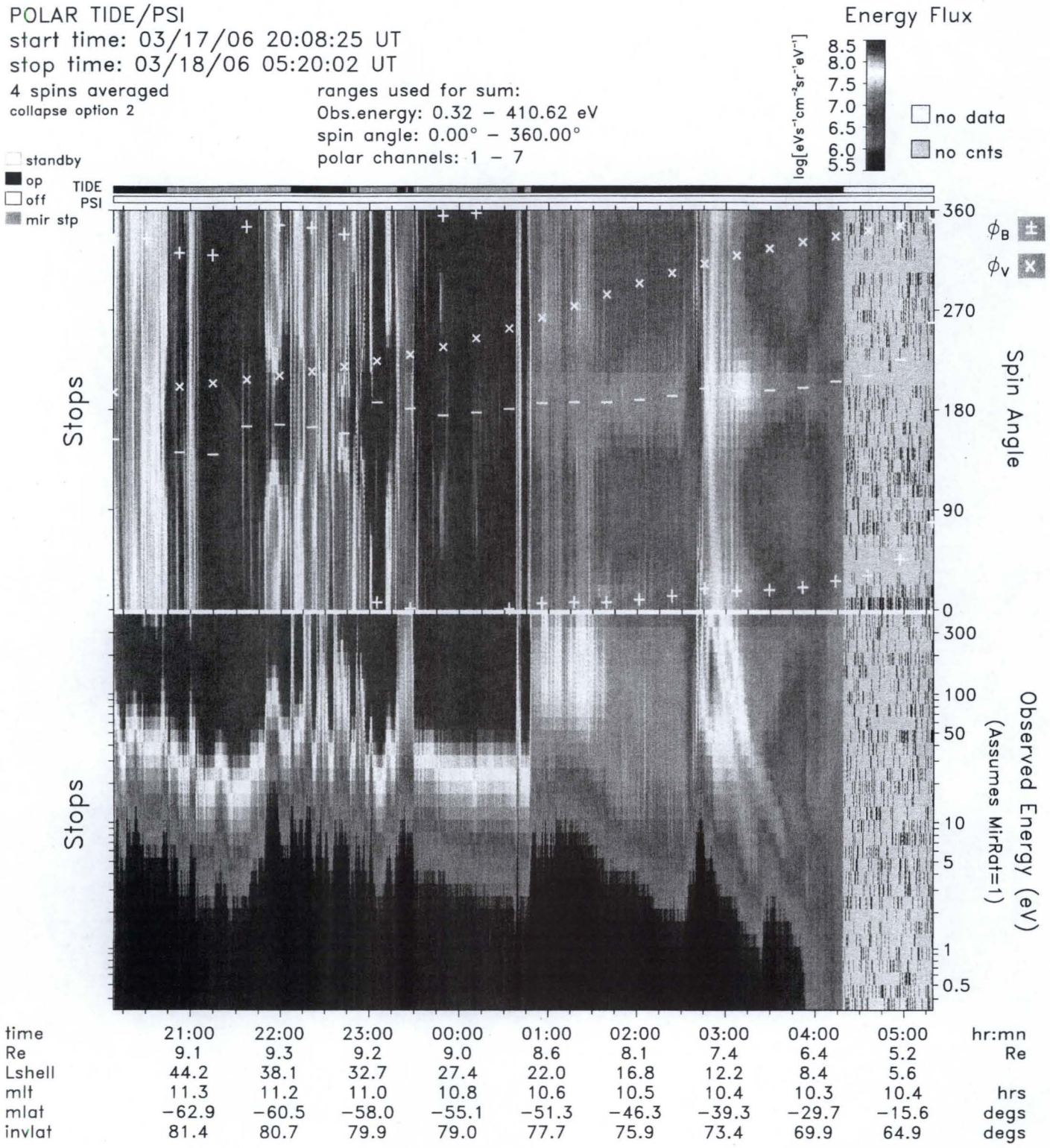
Polar Observations from March 18, 2006

Conditions:

- Polar in the high altitude cusp
- Northward IMF
- Moderately high dynamic pressure

Observations include:

- Overlapping magnetosheath injections
- Long-lived spatial/temporal energy dispersions
- Counterstreaming ionospheric populations



tide_lz_v6.0.0
Wed Mar 22 02:29:41 2006
plot: t0603172008_0520_sp.eshtr.ps
no minimum subtracted

instr_sens: no correction
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mass_calibration: mass_calib.v7
ion_mask: t060317_v2.mask(1.00)

s/c potential = 0.0000
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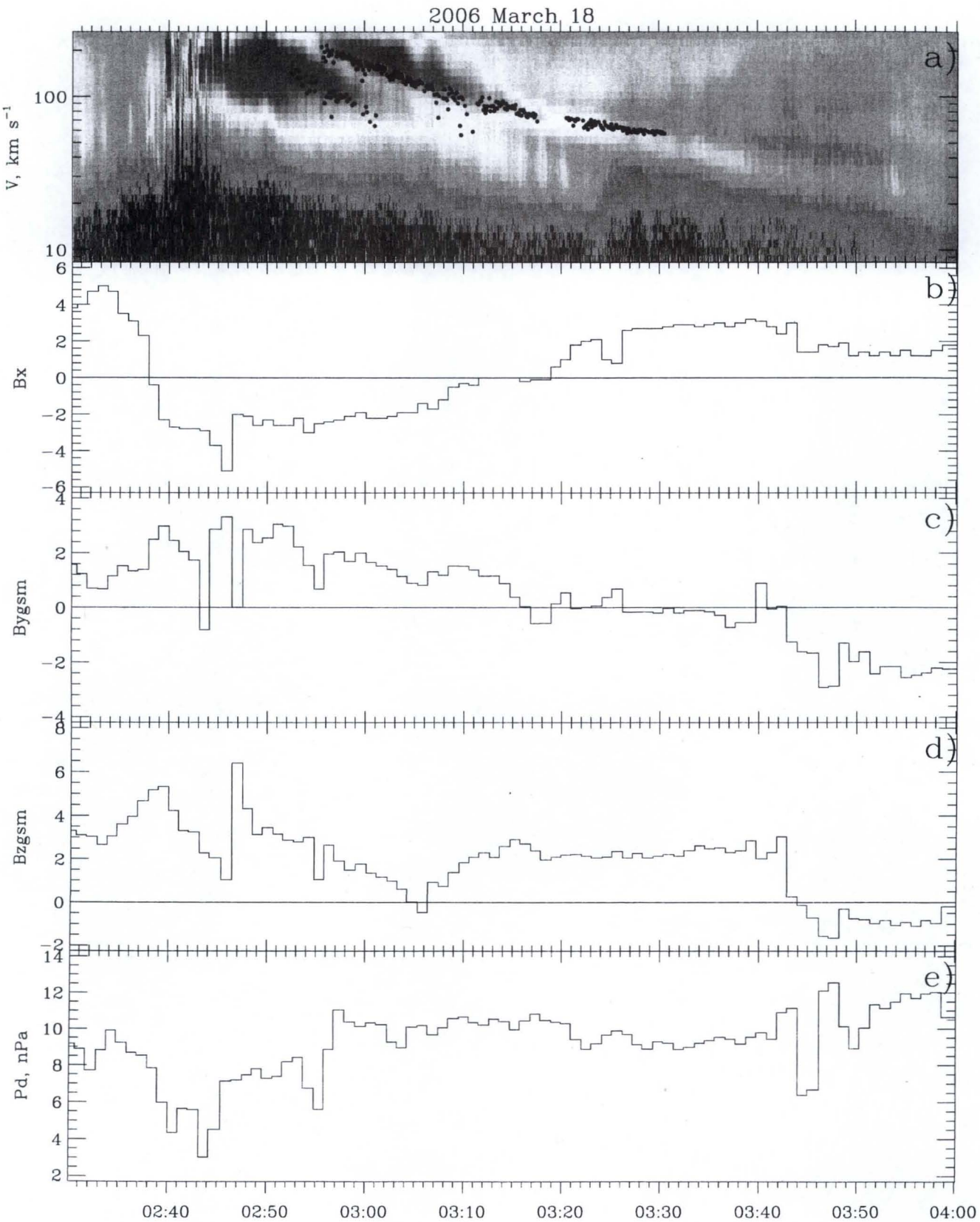
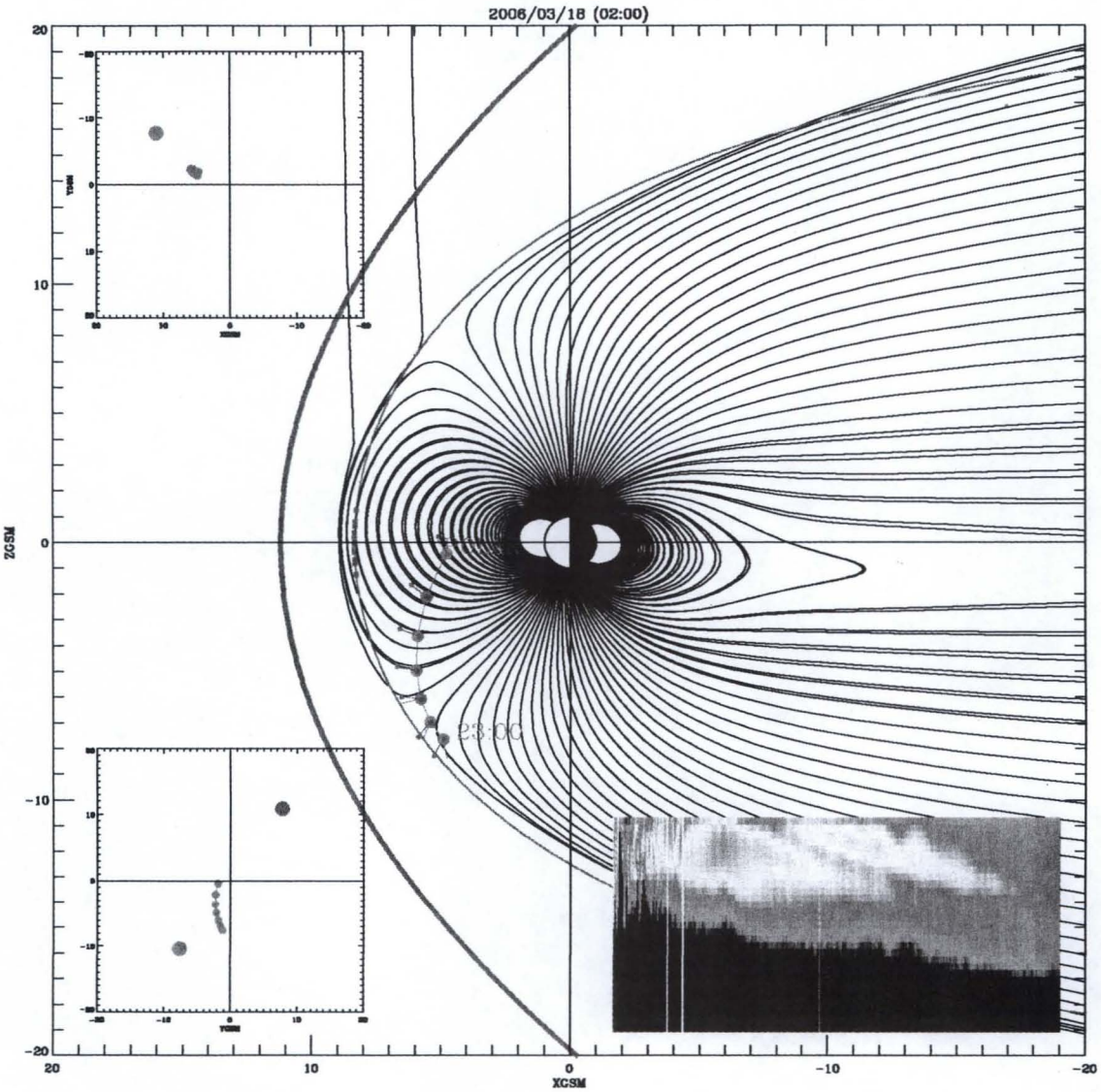
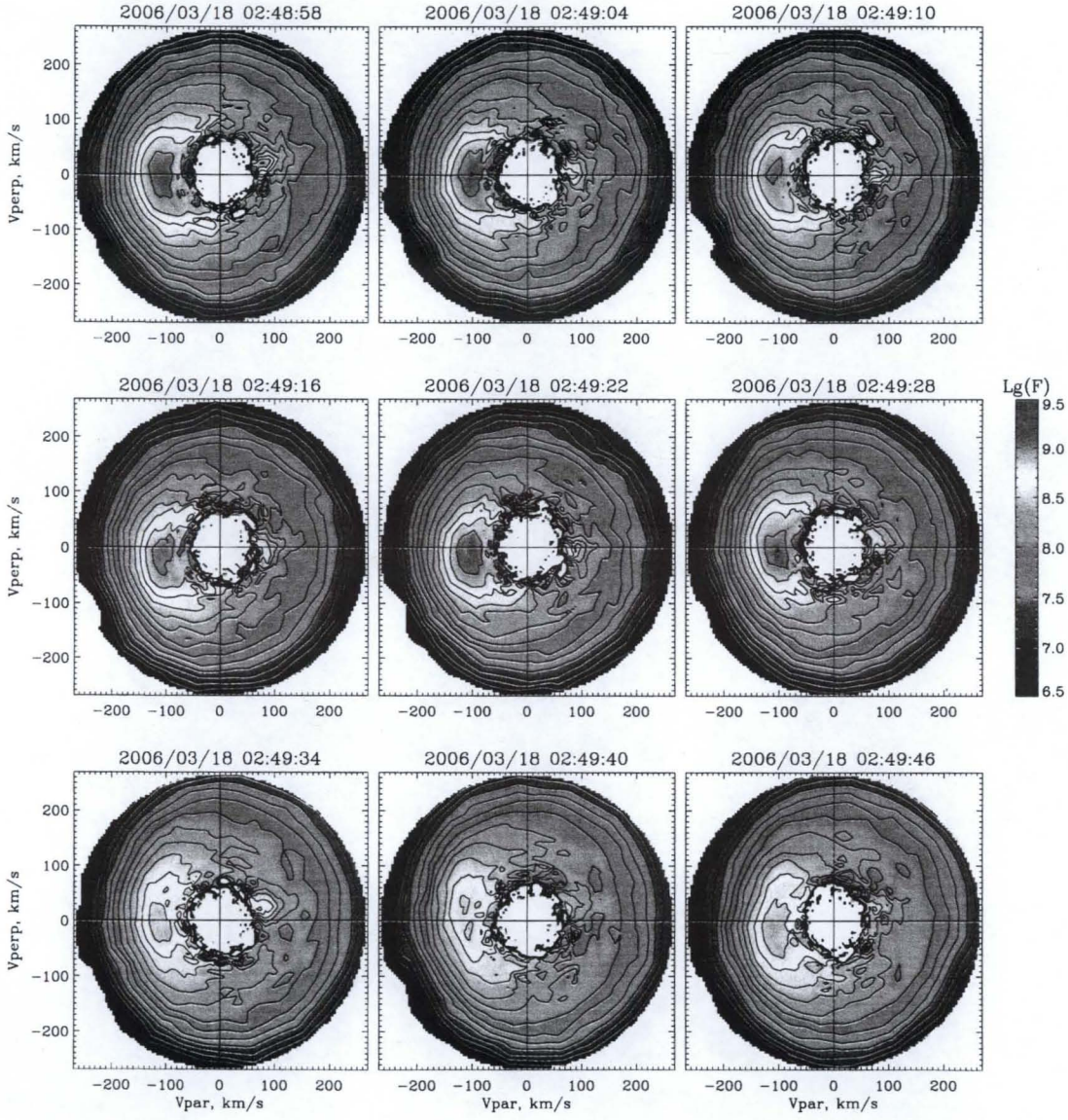
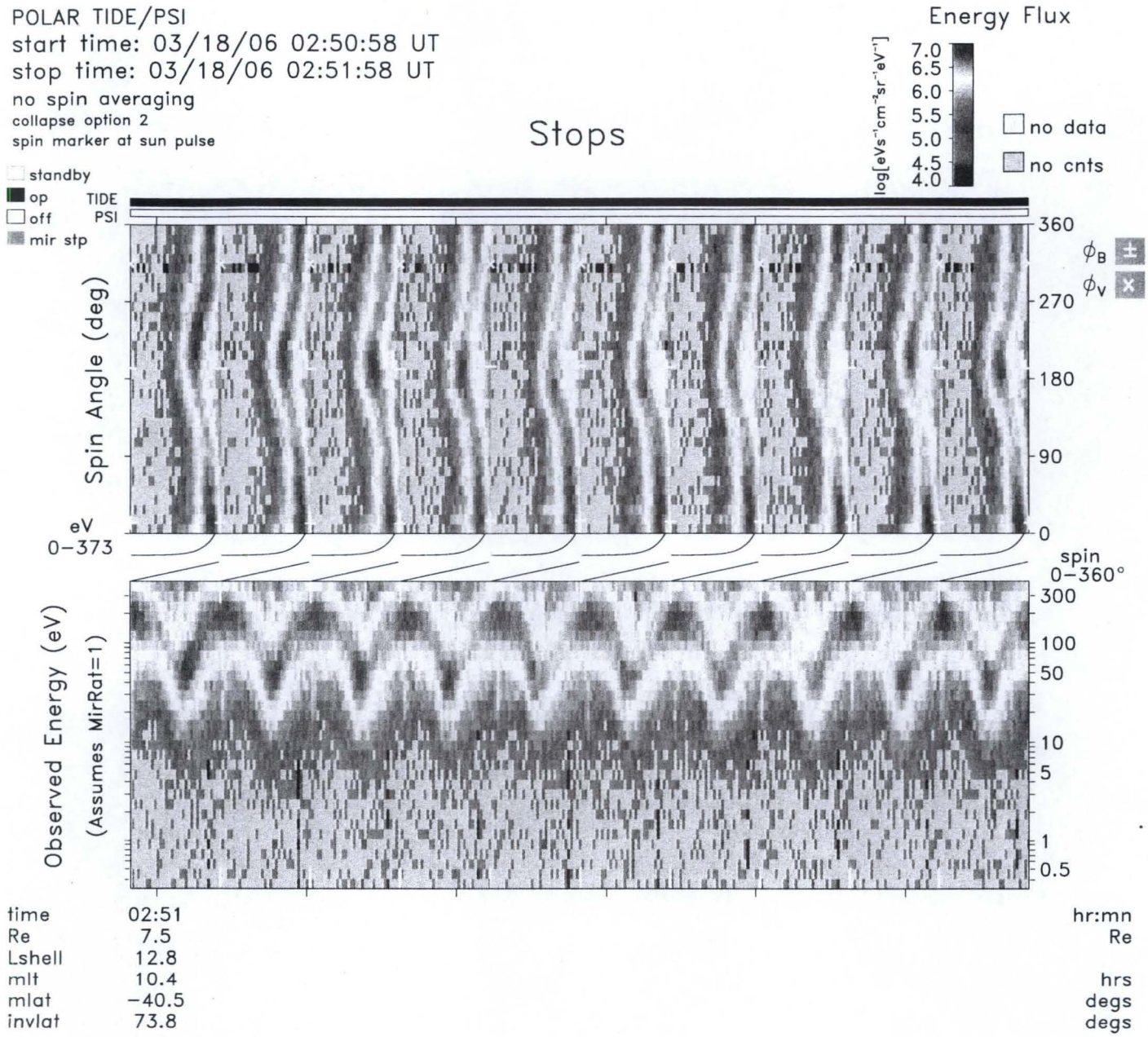
orbit: 06031703.cdf, 06031803.cdf
level-zero: 06031701.dat, 06031801.dat


2006 March 18
a)
V, km s^{-1}
100
10
b)
Bx
6
4
2
0
−2
−4
−6
c)
Bygsm
4
2
0
−2
−4
d)
Bzgsm
8
6
4
2
0
−2
e)
Pd, nPa
14
12
10
8
6
4
2
02:40
02:50
03:00
03:10
03:20
03:30
03:40
03:50
04:00



Pd=8.0; DST= 10; By= 3.0; Bz= 4.0


2006/03/18 02:48:58
2006/03/18 02:49:04
2006/03/18 02:49:10
2006/03/18 02:49:16
2006/03/18 02:49:22
2006/03/18 02:49:28
2006/03/18 02:49:34
2006/03/18 02:49:40
2006/03/18 02:49:46
Vperp, km/s
Vpar, km/s
Lg(F)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
200
100
0
−100
−200



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no minimum subtracted

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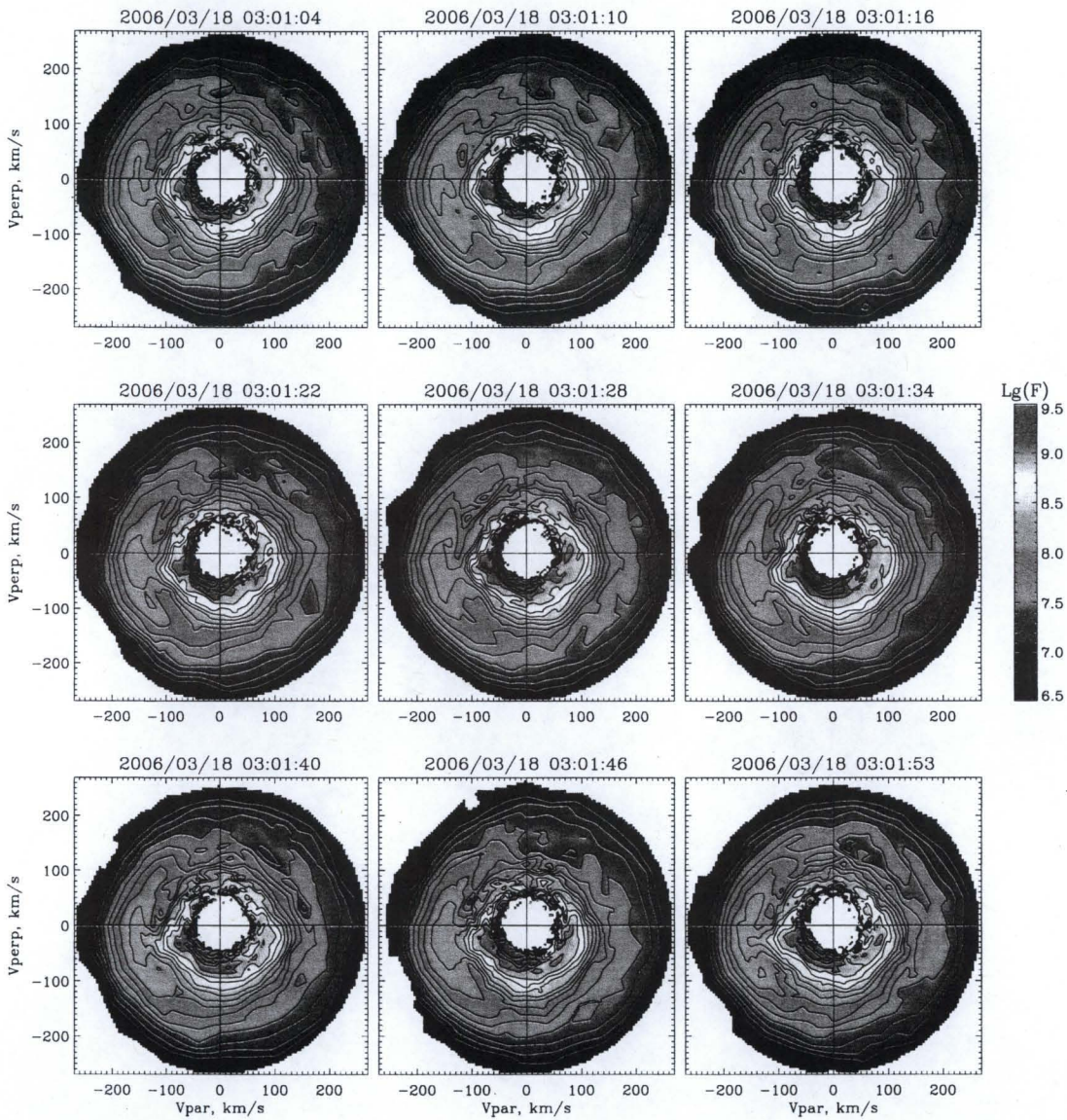
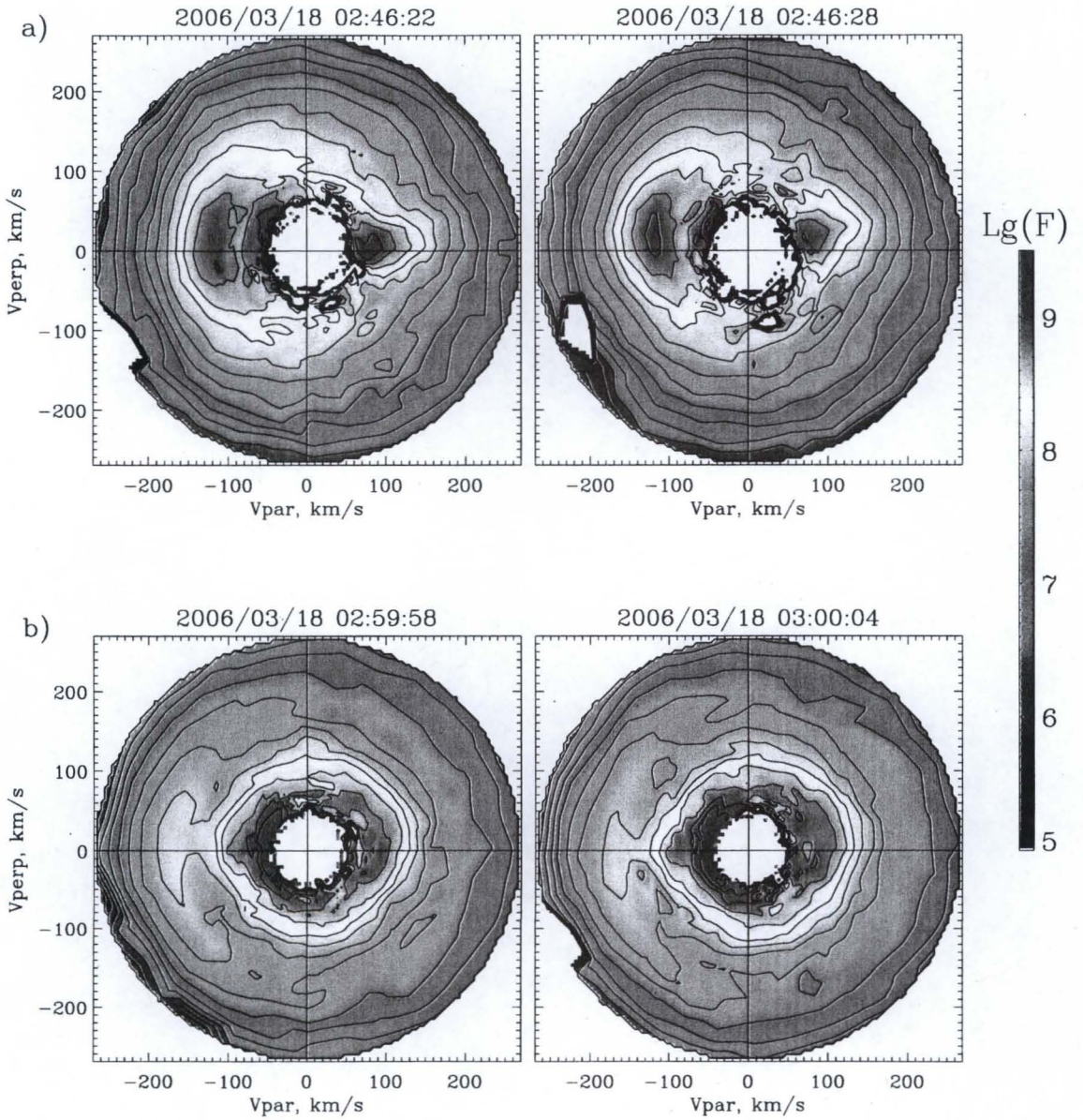
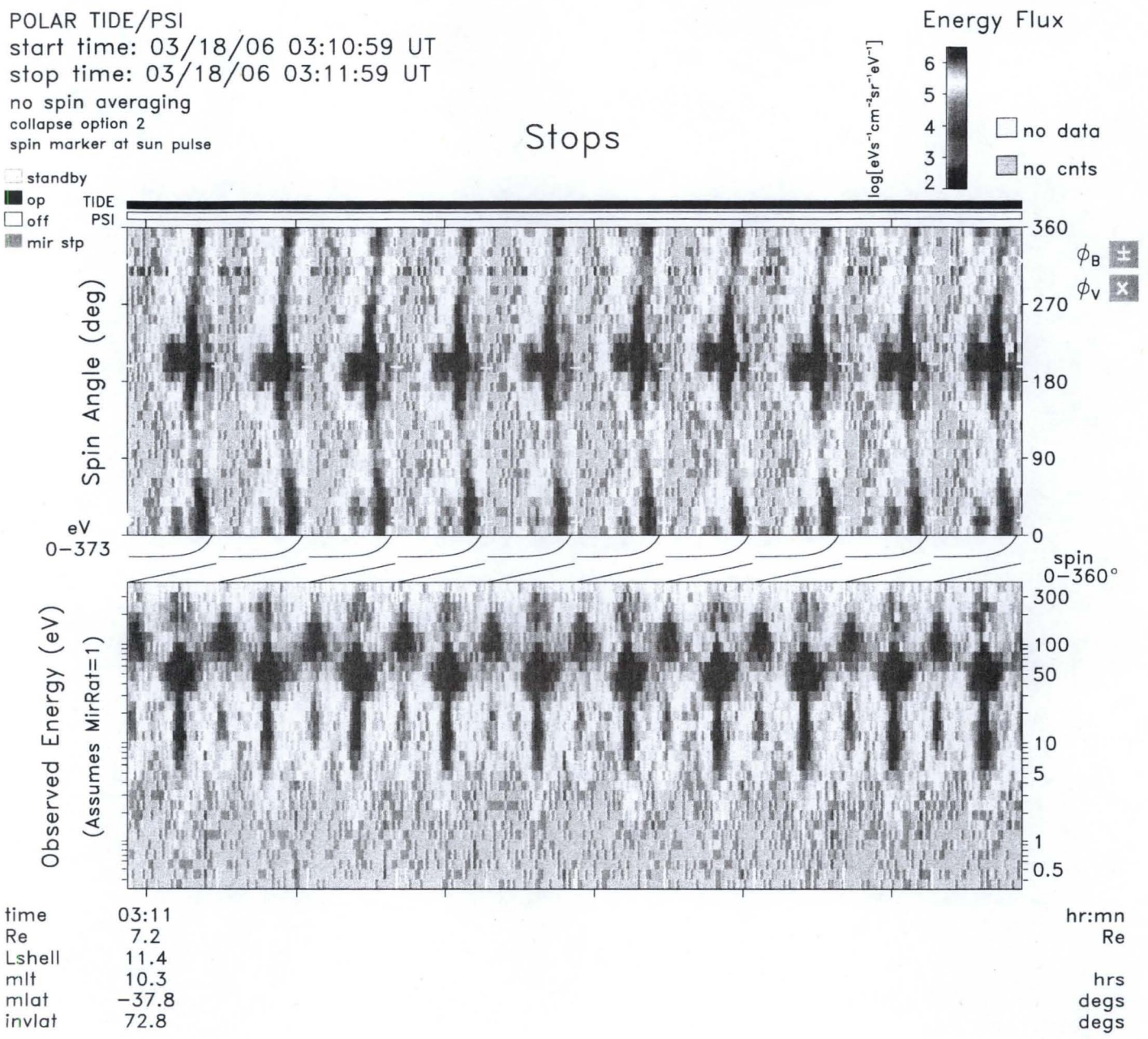
calibration: tide_calib.v6
mass_calibration: mass_calib.v7
ion_mask: t060317_v2.mask(1.00)

s/c potential = 0.0000
attitude: 06031807.cdf
orbit: 06031804.cdf
level-zero: 06031801.dat


2006/03/18 03:01:04
2006/03/18 03:01:10
2006/03/18 03:01:16
2006/03/18 03:01:22
2006/03/18 03:01:28
2006/03/18 03:01:34
2006/03/18 03:01:40
2006/03/18 03:01:46
2006/03/18 03:01:53
Vperp, km/s
Vpar, km/s
Lg(F)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
200
100
0
−100
−200


a)
2006/03/18 02:46:22
2006/03/18 02:46:28
b)
2006/03/18 02:59:58
2006/03/18 03:00:04
Vperp, km/s
Vpar, km/s
200
100
0
−100
−200
Lg(F)
9
8
7
6
5



tide_lz_v6.1.0
Tue Aug 29 12:57:04 2006
plot: t0603180310_0311_sp.q521.esse.ps
no minimum subtracted

instr_sens: no correction
calibration: tide_calib.v6
mass_calibration: mass_calib.v7
ion_mask: t060317_v2.mask(1.00)

s/c potential = 0.0000
attitude: 06031807.cdf
orbit: 06031804.cdf
level-zero: 06031801.dat

The time-of-flight for a given ion is given by (Burch et al., 1986),

$$t_f = \left(\frac{m}{2E}\right)^{1/2} \int_0^s \left\{1 - \sin^2 a_s B(z)/B_s\right\}^{-1/2} dz$$

where,

a_s is the ion pitch angle

$B(z)$ is the magnetic field strength at point z

B_s is the magnetic field strength at the injection point.

Assuming $V_s = V_c$ the time-of-flight, t_f, is related to the time of observations, t, by,

$$t_f = (t - t_o)$$

where t_0 is the time of the initial injection.

Thus for zero pitch angle ions ($a_s = 0$) the following simple relationship between velocity and time applies:

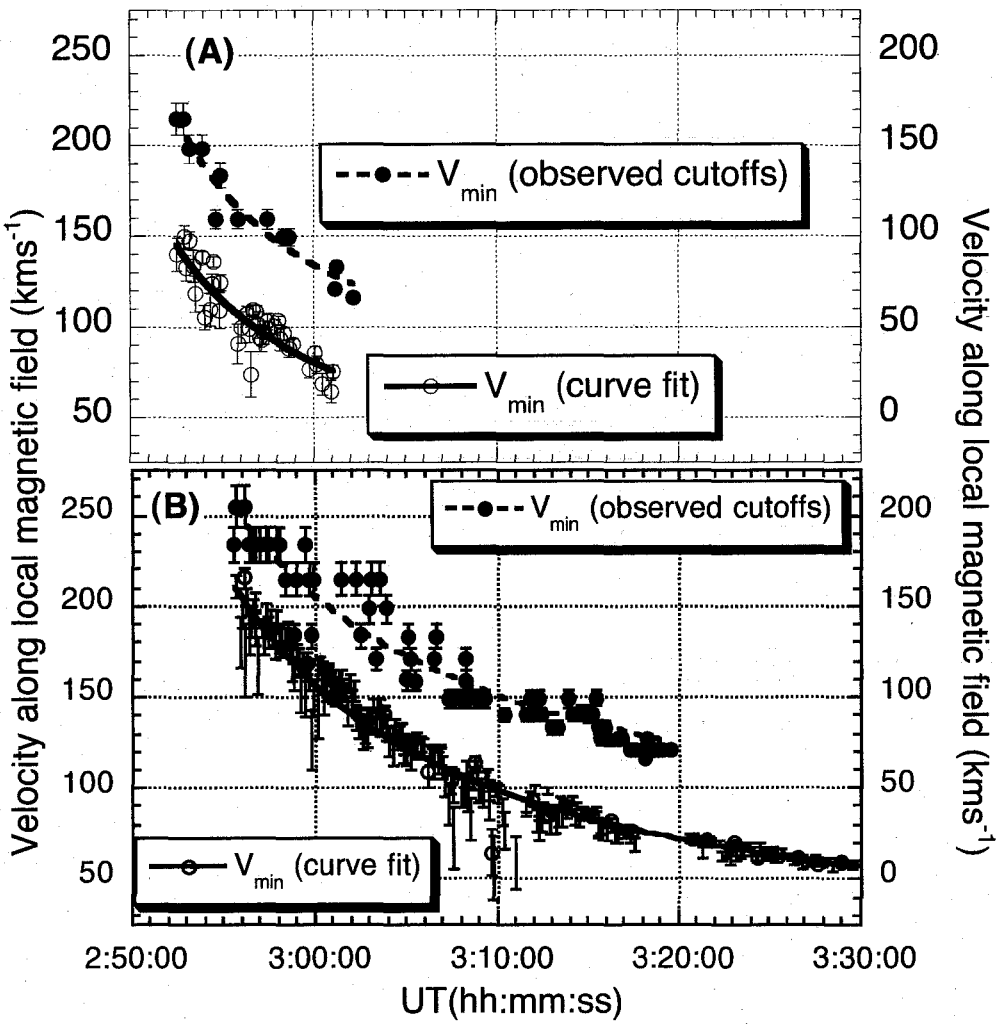
$$V_{\|} = s(t - t_0)^{-1}$$

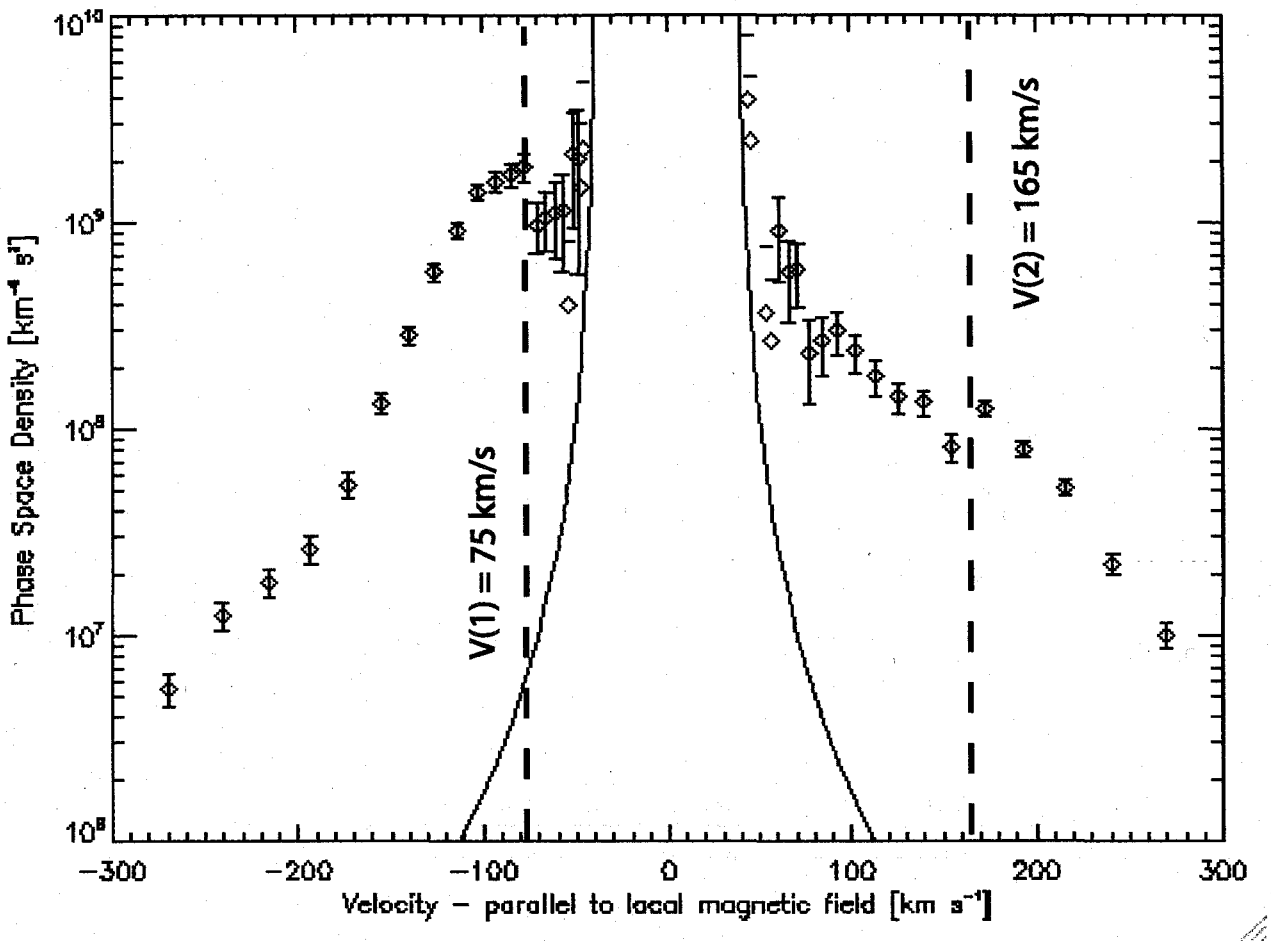
where,

$V_{\|}$ is the speed of the ions parallel to the local magnetic field

s is the distance from the initial injection site to the spacecraft.

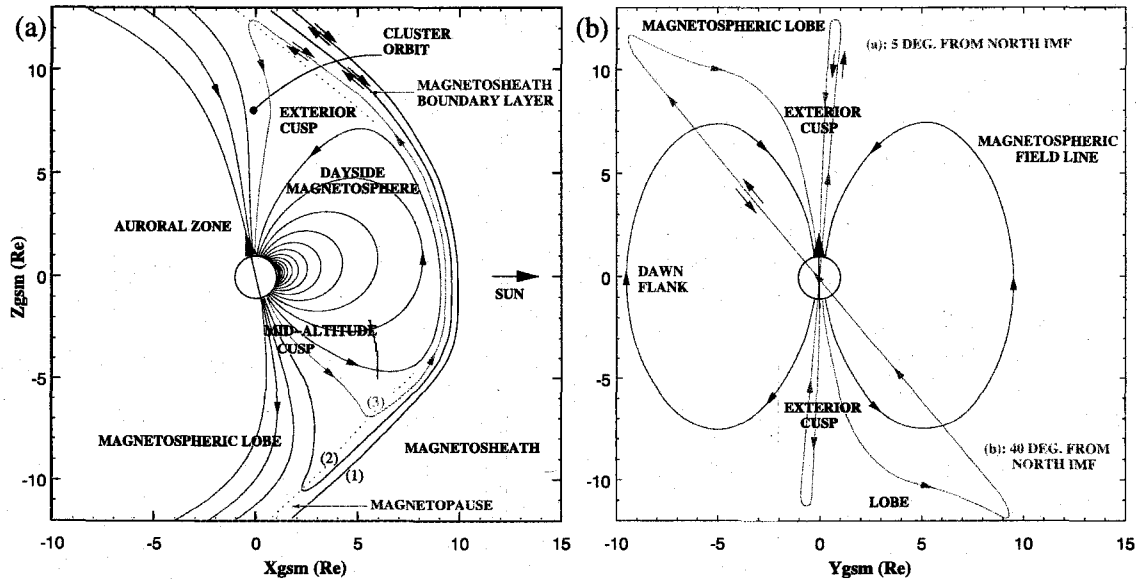
For this analysis $V_{\|}$ is derived by fitting a Maxwellian distribution to the observations at 180° pitch angle.

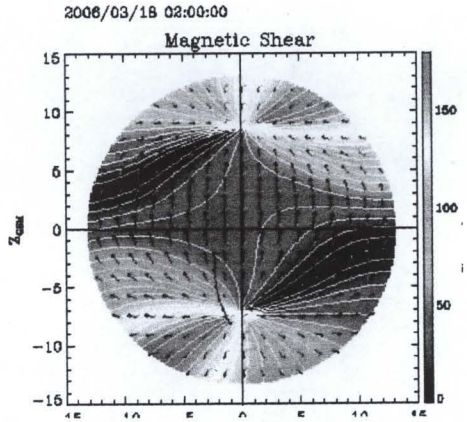

(A)
(B)
V_{min} (observed cutoffs)
V_{min} (curve fit)
Velocity along local magnetic field (kms^{-1})
Velocity along local magnetic field (kms^{-1})
250
200
150
100
50
200
150
100
50
0
2:50:00
3:00:00
3:10:00
3:20:00
3:30:00
UT(hh:mm:ss)

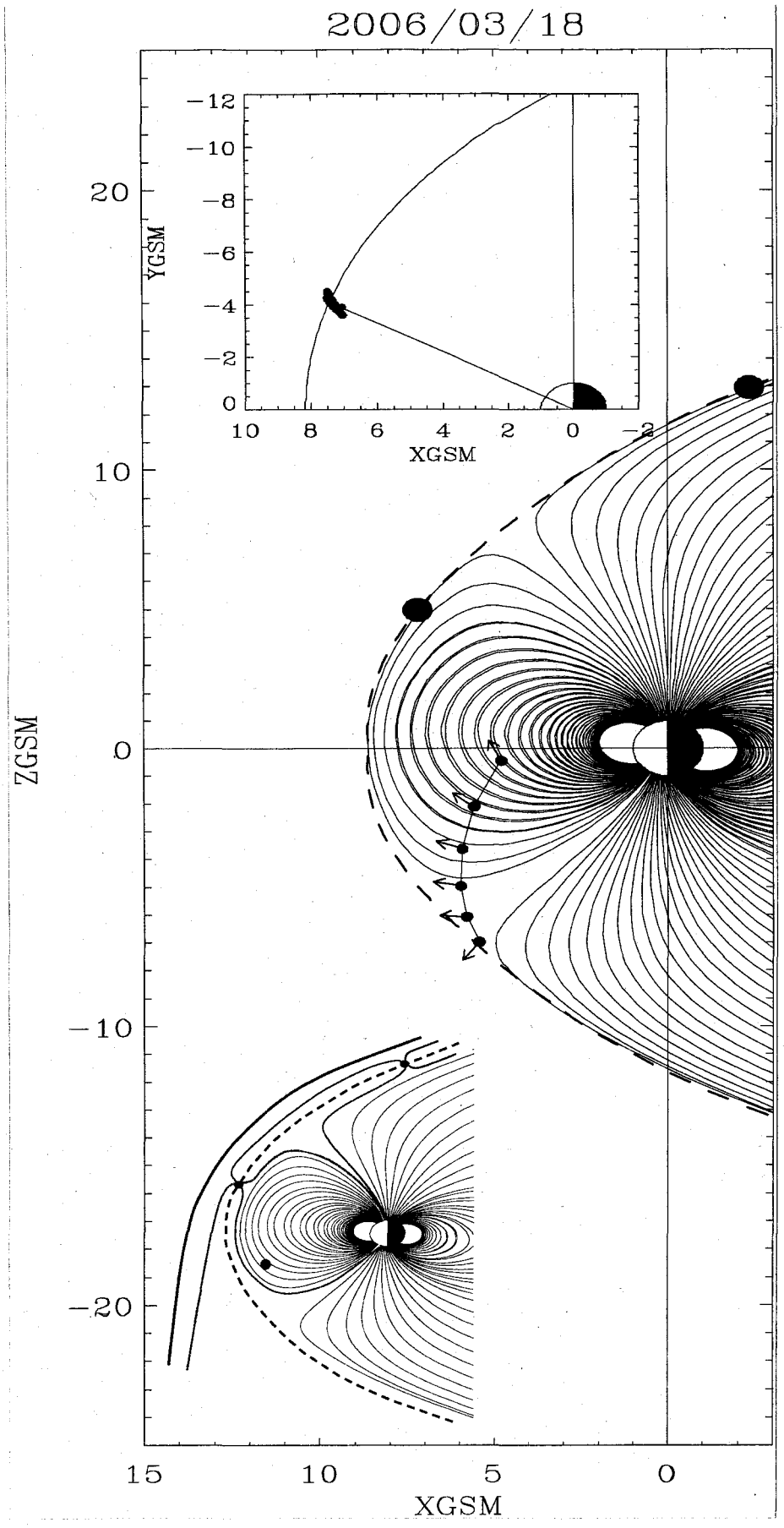


$$D_1 = \frac{D_2 V_1}{V_2 - V_1}$$

$$D_2 = 13 R_E \Rightarrow D_1 = 11 R_E$$


(a)
CLUSTER ORBIT
MAGNETOSHEATH BOUNDARY LAYER
EXTERIOR CUSP
DAYSIDE MAGNETOSPHERE
AURORAL ZONE
SUN
MID-ALTITUDE CUSP
MAGNETOSPHERIC LOBE
MAGNETOSHEATH
(1)
(2)
(3)
MAGNETOPAUSE
Zgsm (Re)
Xgsm (Re)
(b)
MAGNETOSPHERIC LOBE
(a): 5 DEG. FROM NORTH IMF
EXTERIOR CUSP
MAGNETOSPHERIC FIELD LINE
DAWN FLANK
EXTERIOR CUSP
(b): 40 DEG. FROM NORTH IMF
LOBE
Ygsm (Re)


2006/03/18 02:00:00
Magnetic Shear
15
10
5
0
−5
−10
−15
150
100
50
0


2006/03/18
YGSM
XGSM
ZGSM
XGSM

Summary/Conclusions

- Apparent double injection on same field lines
- Counterstreaming ionospheric ions implies closed field lines
- Preliminary analysis suggests "double reconnection" in opposite hemispheres

Problems

- Location of Polar is apparently well inside the magnetopause
- Lack of information on convective motion limits ability to establish time basis

Future

- Waiting for MFE data so that convective motions can be determined
- Will pursue Cluster data where possible

Updated Conclusions

- Reanalysis confirms distances to the two reconnections sites
- Electric field results show a predominantly southward motion of the field lines
- This is not consistent with expected field line motion following post-cusp reconnection

We suggest that it is consistent with a doubly reconnected field line with reconnections sites:

1) in the northern post-cusp region
2) at low-latitude magnetopause